

ACCEPTANCE TEST PLAN(U) WESTINGHOUSE DEFENSE AND  
ELECTRONICS CENTER BALTIMORE MD DEVELOPMENT AND  
OPERATIONS DIV D C KRAUS 28 JUN 85 DCS-13509

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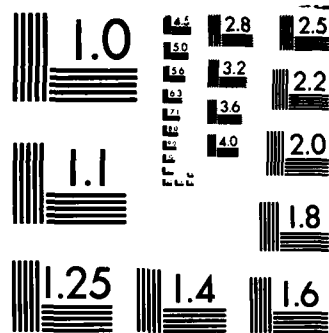
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ACCEPTANCE TEST PLAN FOR SPECIAL RELIABILITY TESTS  
FOR BROADBAND MICROWAVE AMPLIFIER PANEL

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<p>THIS REPORT DESCRIBES THE SPECIAL TESTS AND PROCEDURES THAT WILL BE PERFORMED ON THE BROADBAND MICROWAVE AMPLIFIER PANEL AND THE VARIOUS ESSENTIAL ELEMENTS THAT COMPRISE THE PANEL. THESE TESTS AND PROCEDURES OUTLINED ARE THOSE ITEMS THAT ARE ESSENTIAL FOR RELIABILITY PURPOSES AND ARE USED TO BURN-IN COMPONENTS, SCREEN OUT WEAK PARTS AND DEFICIENCIES, DETERMINE DESIGN DEFICIENCIES, AND ACCUMULATE DATA TO VERIFY AND/OR IMPROVE THE RELIABILITY ANALYSES PERFORMED BEFOREHAND.</p>					
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## 1.0 SUMMARY

This document describes the special tests and procedures that will be performed on the Broadband Microwave Amplifier Panel (henceforth referenced to as the panel) and the various essential elements that comprise the panel. These tests and procedures outlined are those items that are essential for reliability purposes and are used to burn-in components, screen out weak parts and deficiencies, determine design deficiencies, and accumulate data to verify and/or improve the reliability analyses performed beforehand.

## 2.0 SCOPE

This document treats the tests and procedures to be performed only on the broadband panel and its components that are deliverable items under this contract. These tests and procedures are divided into three (3) parts - Transistors, LRUs and Panel - in which different procedures and their results will be specified in this document.

## 3.0 RELIABILITY TESTS AND PROCEDURES

### 3.1 TRANSISTORS

The microwave transistor is the prime component in the panel design and henceforth a prime candidate for study.

#### 3.1.1 SCREENING PROCEDURES

Westinghouse will not perform any burn-in or screening on the transistors by themselves, but will as part of the LRUs (submodules) that comprise the panel. This screening will be specified later on.



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### 3.1.2 RELIABILITY TESTS

A quantity of transistors (a minimum of 5) will be chosen at random from the first lots delivered to Westinghouse by Acrian, the transistor manufacturer. The transistors chosen will be mounted on a small substrate with the various elements (capacitors, coils, resistors) that comprise the matching circuitry of the transistor. The transistor substrate will be mounted on a thermal coldplate and connected electrically.

Three measurements will be monitored - junction temperature ( $T_j$ ), RF output power ( $P_o$ ) and peak current ( $I_k$ ). The junction temperature will be measured using an IR scanning microscope. The following inputs into the circuit will be varied - transistor flange temperature ( $T_f$ ), collector voltage ( $V_{CC}$ ), frequency ( $f$ ), RF power in ( $P_I$ ) and the collector impedance ( $Z_C$ ).

By monitoring  $T_j$ ,  $P_o$  and  $I_k$  as  $T_f$ ,  $V_{CC}$ ,  $f$ ,  $P_I$  and  $Z_C$  are varied, various data will be available for computational and graphical use. Gain, efficiency and thermal characteristics can be computed and plotted versus the various inputs. Also plotted will be Thermal Rieke Diagrams using the junction temperature ( $T_j$ ), RF power out ( $P_o$ ) and the collector impedance ( $Z_C$ ) data.

### 3.2 LINE REPLACEABLE UNITS (LRUs)

The panel consists of 4 main LRUs - submodules, combiners, splitters and circulators.

The submodule consists of the transistors, capacitors, coils and resistors mounted on a soft substrate.

The combiners and splitters are RF power passive devices consisting of mainly stripline and resistors.

The RF circulator is a tuned cavity element and is a passive device.

### 3.2.1 SCREENING PROCEDURES

All of the LRUs mentioned will undergo non-operating thermal cycling to screen out any workmanship defects or design deficiencies. Before thermal cycling the various LRUs will be tested electrically.

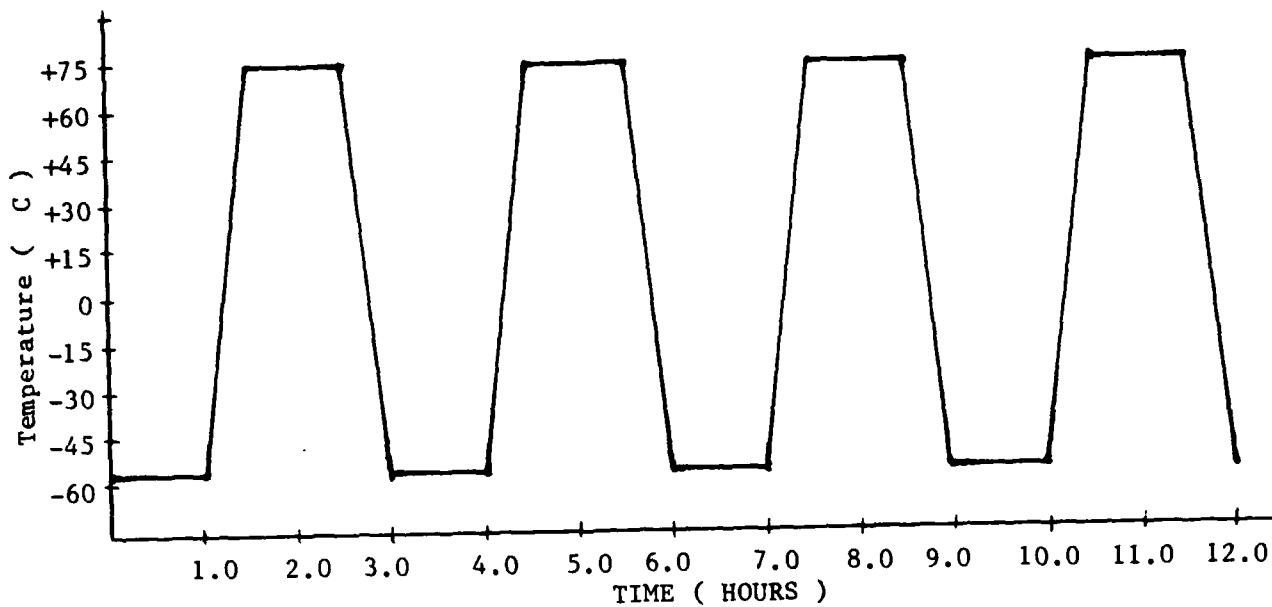
The submodule will be tested for RF power out ( $P_O$ ) and peak current ( $I_k$ ) at five frequency points on the associated bandwidth. This will be at a specified collector voltage ( $V_{CC}$ ), collector impedance ( $Z_C$ ) and RF power in ( $P_I$ ). For the other LRUs - combiners, splitters and circulators - only the input power and output power ( $P_I$  and  $P_O$ ) will be measured and the loss (dB) computed.

The LRUs will then undergo thermal cycling with the submodules experiencing a more severe test than the other LRUs. Figure 1 indicates the thermal cycling profiles for the LRUs. Profile A is exclusively for the submodules and profile B is for all other LRUs.

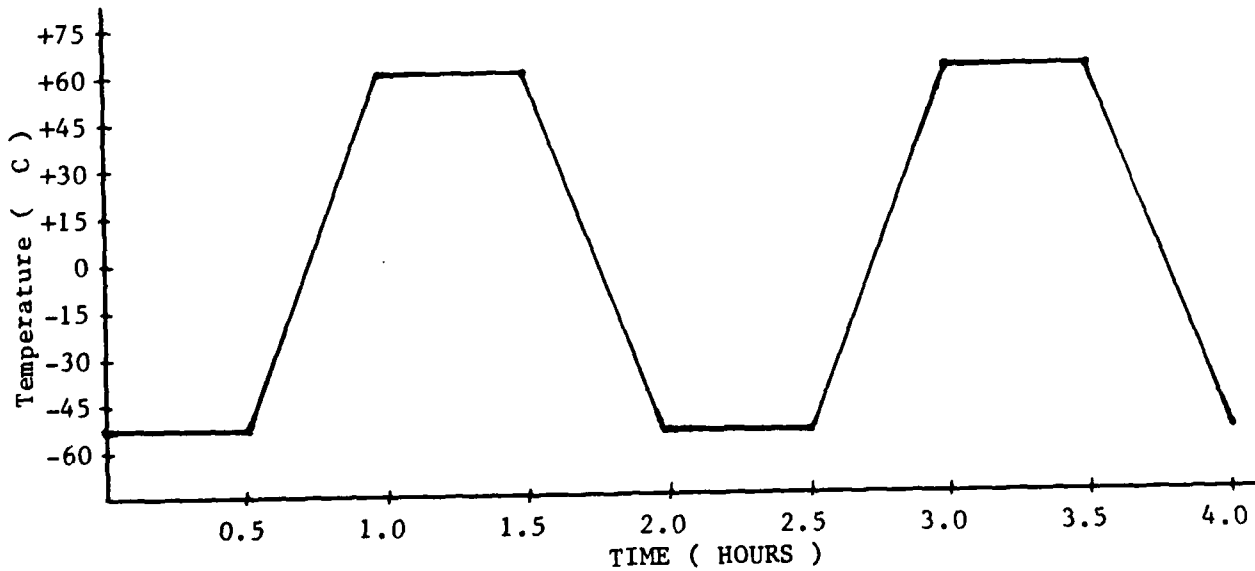
After thermal cycling and before incorporation into the panel all of the beforehand mentioned electrical measurements to the LRUs will be repeated and compared to the previous results. Any noticeable difference in an LRU will be analyzed and any deficiencies corrected before that particular LRU is included into the panel construction.

### 3.2.2 RELIABILITY TESTS

No specific reliability tests are specified for the LRUs with the exception of those mentioned in the screening procedures for LRUs. The data resulting from the screening procedures will be used to compute gain, loss and efficiencies that will be used for comparison with the data and results attained in the reliability tests for the panel as a whole - which are specified in section 3.3.2.



Profile A - Submodule



Profile B - Splitters, Combiners, Circulators

FIGURE 1. Thermal cycling profiles for LRUs



### 3.3 PANEL

This is the final deliverable piece of hardware for the contract - a 10 kilowatt  $\pm$  0.5 dB broadband microwave amplifier.

#### 3.3.1 SCREENING PROCEDURES

Special reliability procedures for the panel will not be performed. By thermal cycling the various LRUs that comprise the panel and careful design consideration Westinghouse is confident that a piece of hardware will be delivered that will pass any and all environmental conditions that result on a shipboard system of which this panel is a building block.

#### 3.3.2 RELIABILITY TESTS

Once the panel has been completed and performs electrically within all specifications, reliability tests will be performed on the panel under two conditions - water cooling and air back-up mode cooling. In both of these scenarios the flow (water or air) will be varied to determine the efficiency and/or effectiveness of the variations. Measurements as described below will be taken for all of the scenarios performed.

Temperature measurements will be taken at various points throughout the panel using thermocouples. Of special interest will be the transistor flange temperature of which will be measured for all transistors. If any large temperature discrepancies for a transistor flange results, the submodules will be rotated to determine if the discrepancy is panel produced. If not, then the submodule will be removed and conditions recreated to determine if the discrepancy is submodule or transistor produced.

RF power will be measured at numerous points throughout the panel with a power probe. The power probe will not measure the exact RF power, but will give measurements directly proportional to the true results. As a result, the gain and losses will be able to be computed and failure and design

deficiencies can be determined. The calculated results can then be compared with the results from the screening procedures for the LRUs and any significant differences determined and analyzed.

#### 4.0 CONCLUSIONS

By performing the reliability tests and procedures documented herein, Westinghouse believes that a sound and functional piece of hardware will be delivered. Also, any design deficiencies determined by these tests and procedures could be corrected if this design is utilized for production of a system. Furthermore, any thermal analyses performed beforehand will be either verified or discovered inaccurate. The results of these tests and procedures will then be folded into both the reliability study to achieve an improved and more correct analysis and into the design to produce a more reliable panel.

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